

Comparison of Life-Cycle Costs for Low-Level Radioactive Waste Management in Texas: Disposal vs. Assured Isolation

*National Low-Level Waste
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**Comparison of Life-Cycle Costs for
Low-Level Radioactive Waste Management in Texas:
Disposal vs. Assured Isolation**

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ABSTRACT

This report documents a comparison of life-cycle costs of an assured isolation facility in Texas versus the life-cycle costs for a traditional below-ground low-level radioactive waste disposal facility designed for the proposed site near Sierra Blanca, Texas.

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1. INTRODUCTION

Under provisions of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPA) and its predecessor law, states and congressionally-authorized compacts of states have sought over the past two decades to develop new low-level radioactive waste (LLRW) disposal facilities. Despite significant and expensive efforts in these endeavors, no such facility has been licensed and actually constructed under provisions of the LLRWPA.

In 1995, the U.S. Department of Energy's National Low-Level Waste Management Program (the Program) described assured isolation as an alternative approach to safe long-term management of LLRW. The assured isolation concept involved placing LLRW in a licensed, engineered facility, from which the waste could be subsequently retrieved for other disposition, if necessary. The facility was described as remaining under license as long as radioactive materials were present at the facility. The conceptual facility relied on ongoing and continuing inspection, monitoring, and preventive maintenance. These assumptions contrasted the assumption for disposal facility licensing that institutional control would be lost at 100 years following disposal facility closure and that the facility must, thereafter, meet LLRW disposal performance objectives without reliance on ongoing active measures.

From 1996 through 1998, the Program sponsored a study to estimate the life-cycle costs and evaluate the economics of assured isolation relative to LLRW disposal. This investigation responded to a request from the State of Connecticut to assess the assured isolation concept's viability (Ch98). In that investigation, the characteristics of the assured isolation facility (AIF) and those of the LLRW disposal facility were constrained to be similar so the results would be comparable. No effort was made to optimize the AIF design characteristics in order to minimize life-cycle costs, although it was agreed that considerable design flexibility exists that could reduce estimated AIF life-cycle costs.

Early in 1999, the Texas Low-Level Radioactive Waste Disposal Authority (the Authority) requested the Program to sponsor an investigation to optimize principal design characteristics of the AIF concept and to estimate associated life-cycle costs. In this investigation, the objective was to consider the cost saving effects of design changes that could be implemented without compromising the ability of the AIF to satisfy regulations believed to be applicable (as described in Si98). The Authority sought life-cycle cost information that they could compare to life-cycle cost estimates for the Texas LLRW disposal facility (Ba99a).

The Program contracted with Rogers and Associates Engineering (RAE) to conduct the investigation the Authority had requested. The results of that investigation are contained in Ba99b.

This document compares the estimated costs of two LLRW management concepts – near-surface land disposal using below-ground modular concrete canisters in excavations and assured isolation, using modular concrete canisters in above-ground concrete structures. In this report, the principal features of these two management concepts are summarized and their cost differences identified and compared.

2. COMPARISON OF FACILITY FEATURES AND LIFE CYCLES

A concerted effort was made to prepare an optimized AIF conceptual design that was similar in its features and characteristics to those of the proposed Texas LLRW disposal facility. However, several conditions existed that precluded perfectly parallel facility features and life cycles. This chapter compares the features and life cycles of the AIF and the LLRW disposal facility

2.1 Physical Description

The proposed Texas LLRW disposal facility would be licensed under state regulations that are compatible with the Nuclear Regulatory Commission's regulations for land disposal of LLRW. Title 10 of the Code of Federal Regulations, Part 61 (10 CFR 61). Under 10 CFR 61, active measures of inspection and maintenance could not be counted upon for more than 100 years in demonstrating that the facility would meet its performance objectives during the licensing process. At some future date, when regulatory agencies might be satisfied that the facility is performing acceptably, the license might be terminated.

The disposal facility involved placing waste containers received into modular concrete canisters. Voids within these canisters would be backfilled with grout. The closed canisters would be emplaced in a shallow excavation such that the top of the canisters would be well below site grade. Voids between canisters would be backfilled with earthen materials and the entire excavation covered with an engineered, multi-layer earthen cover system. The disposal facility would rely primarily on natural features of the site where the facility was developed to isolate the waste. The facility would not rely on active ongoing measures beyond 100 years after facility closure to accomplish its containment functions.

The conceptual AIF design developed for the Program would be licensed as a radioactive materials facility under Title 10 of the Code of Federal Regulations, Parts 30, 40, and/or 70 (10 CFR 30, 40, and/or 70). As long as radioactive materials were present at the facility, the facility would remain under active license and its owners would be accountable to regulatory agencies to properly manage the facility.

The AIF would involve placing waste containers received into modular concrete canisters. Voids within these canisters would be backfilled with absorbent, granular material. The closed canisters would be emplaced in an above-grade concrete structure designed, constructed, operated, and maintained to contain the waste under license for hundreds of years. The facility would accomplish its containment function through reliance on engineered structures and active inspections and maintenance activities as long as radioactive materials were present at the facility.

A central concept of the AIF is the preservation of future management options. If LLRW were placed in an AIF, provisions would be made in advance for implementing management options in the future. Such management options might include recycling, retrieval and subsequent disposal, and continued management in the AIF.

The following table summarizes principal features of the LLRW disposal facility and of the AIF.

Characteristic	Disposal Facility	Assured Isolation Facility
Waste Package	Shipping Containers in Concrete Canisters	Shipping Containers in Concrete Canisters
Waste Management Unit	Earthen Excavation	Concrete Structure
Weather Protection	Engineered Earthen Cover System	Concrete Structure
Principal Component for Waste Isolation	Natural Site Features without Reliance on Ongoing Activities	Engineered Structure with Active Inspection, Maintenance, and Repairs as Needed
Monitoring Systems	Environmental Media	Facility Components such as Isolation Unit, Moisture Detection and Collection Systems

The annual waste receipts that would be managed at either facility were similar for the first 20 years of their lives. A total of just more than 1 million cubic feet of LLRW was estimated to require management in the facilities in the first 20 years of facility life. The annual waste receipt rate was estimated to range from about 31,000 to about 112,000 cubic feet per year, with an average of about 51,000 cubic feet per year during these 20 years. In the last 10 years of AIF life (see Section 2.2), the waste receipt rate was estimated to be about 78,000 cubic feet per year to bring the total amount of waste requiring management to about 1.8 million cubic feet.

2.2 Life Cycles

The life cycles of the two LLRW management facilities considered in this investigation were not identical. They are summarized below:

Life Cycle Period	Disposal Facility	Assured Isolation Facility
Pre-Operations	8 years	5 years
Operations	20 years	30 years
Inspection and Preventive Maintenance	No more than 100 years for licensing purposes	At least 300 years or as long as radioactive materials are present in the facility
Post-Institutional Control Custodial Maintenance	Centuries	None—Facility will remain under license as long as radioactive materials are present in the facility.

The shorter Pre-Operations period for the AIF is based on the expectation that disposal facility site characterization will take longer to complete. Furthermore, it is expected that public opposition to the development of the AIF will not be as active or intense as with the disposal facility.

2.3 Adjustments to Estimated Disposal Costs to Allow Comparison with AIF Cost Estimates

Estimated costs for the disposal facility differed from those for the AIF in at least two ways: pre-operating costs and liability insurance premiums. Adjustments were made to allow these two cost estimates to be compared. These adjustments are described in the following sections. The original cost estimate is summarized in Appendix A and its details are presented in Appendix B.

2.3.1 Pre-Operating Costs

In estimates of disposal facility operating costs, the costs needed to develop the disposal facility were not included. Since pre-operating costs were included in the AIF cost estimates, an adjustment was required before a reasonable comparison of life-cycle costs could be made.

The Authority incurred costs over an eight-year period from 1992 through 1999. For reasons stated in *Design Study and Cost Estimate for an Assured Isolation Facility in Texas* (Ba99b), a shorter development or pre-operating period for AIF was considered justifiable. The AIF pre-operating period was estimated to last only six years. The spending profile for AIF was assumed to be the same as that of the first five years of the disposal facility development. In the sixth year, costs to construct and startup the AIF were taken to be identical to the estimated costs to construct and startup the disposal facility. The profile of annual costs to develop the optimized AIF was thus estimated to be as follows:

Year	Site Development Costs (\$000)	Facility Construction and Startup Cost (\$000)
1	\$1,555	
2	2,937	
3	1,357	
4	1,021	
5	1,961	
6		\$7,913
TOTALS	\$8,831	\$7,913

The adjustment made to the earlier disposal facility cost estimate for pre-operating costs was taken to be the AIF profile of pre-operating costs. The estimated AIF pre-operating cost of \$16.7 million was smaller than the historical disposal facility costs by about \$1.7 million, which were the Authority's actual cost in years 6 and 7. The estimated AIF pre-operating costs are believed to be conservatively large.

Because the pre-operating costs are based on historical costs, their escalated costs are less and their present values are greater than their constant-dollar equivalents, contrary to expectations for costs incurred in the future. The escalated costs totaled \$15.5 million, while present values totaled \$19.1 million.

2.3.2 Liability Insurance

The disposal facility cost estimate made no allowance for liability insurance, as did the AIF cost estimate. To make the estimates comparable, the annual liability premium of \$50,000 was added to the costs estimated earlier for the disposal facility. This added a total of about \$1.5 million (constant dollars) over the disposal facility's 30-year life (or \$1.0 million in constant dollars over the first 20 years of disposal facility life).

3. ECONOMIC COMPARISON

Several summary-level indicators of economic performance of the disposal facility and the AIF are summarized in Table 3-1. The principal comparison of this table is of the first 20 years of the AIF operating period. Costs for the full 30 years of AIF waste acceptance are included for continuity (Ba99b).

Table 3-1. Comparison of LLRW disposal facility and AIF costs.

Indicator	LLRW Disposal Facility 20-Year Costs	Assured Isolation Facility 20-Year Costs	AIF 20-Year Costs As Percent Of Disposal Facility 20-Year Costs	Assured Isolation Facility 30-Year Costs
Total Cost				
Constant Dollar	\$160,000,000	\$280,000,000	175%	\$436,000,000
Escalated Dollar	\$220,000,000	\$370,000,000	168%	\$640,000,000
Present Value	\$150,000,000	\$230,000,000	153%	\$318,000,000
Total Volume (cf)	1,019,188	1,019,188		1,800,000
Escalated Dollar Unit Charge				
Initial	\$136 per cf	\$187 per cf	138%	\$187 per cf
Minimum	\$133 per cf	\$187 per cf	140%	\$187 per cf
Maximum	\$344 per cf	\$670 per cf	195%	\$670 per cf
Escalated	\$232 per cf	\$362 per cf	156%	\$358 per cf
Cost Divided by Total Volume				
Present Value Unit Charge				
Initial	\$136 per cf	\$187 per cf	138%	\$187 per cf
Minimum	\$96 per cf	\$130 per cf	135%	\$84 per cf
Maximum	\$223 per cf	\$420 per cf	189%	\$420 per cf
Present	\$146 per cf	\$230 per cf	158%	\$177 per cf
Value Divided by Total Volume				

This summary clearly shows that the various AIF total costs are estimated to be 50 to 75 percent greater than those of the disposal facility. AIF unit charges range from 135 to 195 percent of corresponding disposal facility unit charges.

A few important facts cause the estimated costs of the AIF to be more than those for the disposal facility. The single most significant fact is the requirement to accumulate a financial assurance fund of sufficient magnitude to ensure that (1) up to 300 years of inspection and preventive maintenance will be funded, and (2) waste can be retrieved and transferred to another facility after 100 years in the AIF. In the first year of AIF operation, this requirement adds about \$5.6 million to the cost of facility operation. This increment alone increases the cost for that year by over 50 percent. This requirement continues in subsequent years to significantly increase the costs that must be recovered through facility revenues.

Other reasons AIF costs exceed those of disposal include:

- As permitted by rule, disposal facility life-cycle cost estimates include no allowance for retrieving and re-disposing of waste
- Increased construction costs (more costs for reinforced concrete structures, although less for excavation)
- Increased utility costs (because air inside the AIF must be conditioned)
- Assumed increased monitoring intensity (consistent with the AIF commitment to actively monitor and maintain the facility)

Since incentive payments to the host community (10 percent of total revenues) and contingency allowance (20 percent of estimated costs) are scaled from other costs, these items also contribute to the increased costs of the AIF, relative to those of disposal.

The 30-year values for AIF are taken from the AIF design report (Ba99b) to provide continuity between that report and this comparison. Because the 30-year volumes are greater than the 20-year volumes by 70 to 80 percent, the 30-year estimated costs, as expected, exceed the 20-year estimated costs.

4. REFERENCES

- Ba99a Baird, R.D., B.C. Rogers, and P.L. Walter, "Life-Cycle Cost Study for a LLW Disposal Facility in Texas," DOE/LLW-256, Rogers and Associates Engineering Corporation for DOE's National Low-Level Waste Management Program, August 1999.
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- Ch98 N. Chau, A.A. Sutherland, and R.D. Baird, "Life-Cycle Costs for Disposal and Assured Isolation of Low-Level Radioactive Waste in Connecticut," DOE/LLW-246, Rogers and Associates Engineering Corporation for DOE's National Low-Level Waste Management Program, March 1998.
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Appendix A
"Texas Life-Cycle Cost Study";
Summary

Table A-1. Summary of estimated Texas disposal facility life-cycle costs.

Cost Component	Million of 1997 Dollars	Percent Subtotal
Class A Disposal Unit Costs	55.0	46.6
Payroll	22.8	19.3
Construction Equipment Lease/Purchase	13.7	11.6
Utilities and Consumables	5.6	4.8
Authority Administration	4.8	4.1
Post-Closure Maintenance Fund	4.5	3.8
Class B/C Disposal Unit Costs	4.4	3.7
All Others	<u>7.2</u>	<u>6.1</u>
Subtotal Costs	118.0	100.0
Contingency Allowance	11.4	9.7
Incentive Payments	<u>12.9</u>	<u>10.9</u>
Total Estimated 20-Year Cost	142.4	120.7

Appendix B

"Texas Life-Cycle Cost Study"; Cost Estimate Spreadsheets